Journal of Applied Physics 2006 vol.99 N8

Spin screening of magnetic moments and inverse proximity effect in ferromagnet/superconductor nanostructures

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Abstract

It is shown that the short-range oscillating spin polarization of conduction electrons around a magnetic moment embedded in a superconducting film is screened by a long-range antiferromagnetic term, which has its origin in Cooper pairing. Using these results, an exchange model of the proximity effect in ferromagnet/superconductor (F/S) nanostructures is proposed. The mutual accommodation of inhomogeneous superconducting and magnetic order parameters in the F/S nanostructures is studied within the framework of this model. It is shown that F/S nanostructures of the first type allow only the presence of homogeneous ferromagnetic ordering in the F layers that coexists with superconductivity in the S layers if the exchange fields h are lower than a critical field hc. It is found that in the F/S nanostructures of the second type for exchange fields h between hc1 and hc2, where hc1 (2) is the lower (upper) critical exchange field, a nonuniform cryptoferromagnetic modulation is induced in the spin structure of the F films. The conditions for the coexistence of inhomogeneous magnetism and superconductivity in the F/S nanostructures EuOAl, EuOV, EuSAl, and LaCaMnOYBaCuO are explored. The theory is used to interpret the experimental data. © 2006 American Institute of Physics.

http://dx.doi.org/10.1063/1.2172910